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NAVPACMETOCDETMISAWAINST 3140.1 CHANGE TRANSMITTAL 1

From: Officer in Charge, Naval Pacific Meteorology and Oceanography Detachment, Misawa, Japan
To: Distribution

Subj: OCEANOGRAPHIC FORECASTER'S HANDBOOK

Encl: (1) Reprinted cover page, reprinted section I (pages 1 through 3), reprinted section II (page 4), reprinted section IV (page 13), reprinted section V (page 15).

1. Purpose. To transmit change 1 to subject instruction.

2. Summary of Changes. Changes reflect the command name change, equipment upgrades, and clarification of rules of thumb.

3. Action.

a. Replace cover page.
b. Replace section I, pages 1 through 3.
c. Replace section II, page 4.
d. Replace section IV, page 13.
e. Replace section V, page 15.

M.R. ROCHELEAU

NAVOCEANCOM DET MISAWA INSTRUCTION 3140.1A

Subj: U.S. NAVAL OCEANOGRAPHY COMMAND DETACHMENT, MISAWA, JAPAN
OCEANOGRAPHIC FORECASTER'S HANDBOOK

1. Purpose. To establish a handbook which will assist oceanographic forecasters in becoming familiar with NAVPACMETOC DET Misawa area of responsibility.

2. Cancellation. The Oceanographic Forecaster's Handbook for NAVOCEANCOM DET Misawa dated JAN 1986 is hereby canceled.

3. Discussion. This Oceanographic Forecaster's Handbook has been prepared to provide personnel assigned to NAVOCEANCOM DET Misawa information and insight into the dynamic and unique oceanographic conditions within the Misawa AOR. It will also assist other oceanographic forecasters operating in the local geographic area.

4. Action. All personnel attached to NAVOCEANCOM DET Misawa will become familiar with the contents of this handbook.

JESSIE C. CARMAN

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REFERENCES

1. Naval Environmental Prediction Research Facility (NEPRF), Monterey, CA, 1988, Forecasters Handbook for Japan and Adjacent Sea Areas. Commander Naval Oceanography Command, NSTL Station, Bay St. Louis, MS 39529.

2. Naval Oceanography Office, Stennis Space Center, MS, 1991, Environmental Guide to Sea of Okhotsk (u), Commander Naval Oceanography Command, NSTL Station, Bay St. Louis, MS 39529.

3. Commander Submarine Development Squadron TWELVE, Groton, CT, Tactical Use of the Ocean Environment, 1989.

Table Of Contents

SECTION I
BASIC DESCRIPTION

1. **Location and Description**.

Misawa Air Base is located on a small coastal plain (4042N-14123E), near the northern tip of Honshu, the largest of the Japanese Islands. The base has a field elevation of 119 feet. Fifty-two miles to the north of Misawa is the northern shore of Honshu and the Tsugaru Strait. Sixty-eight miles west is the Sea of Japan, and three miles east is the Pacific Ocean. The area within 10 nautical miles of Misawa is generally flat, less than 250 feet above mean sea level, consisting of forests and farmland. The northern portion of the Ou Mountains lies 20 to 30 miles from Misawa forming a protective arc south-southwest to northwest. The mountains range from 3000 to 5000 feet elevation, with two peaks at 5200 and 5332 feet high. NAVPACMETOC DET Misawa is located in the south end of the Base Operations building, 998 . The detachment was established in 1972 to support Naval units operating from and around Misawa. In April of 1985, the aviation flight briefings and weather warning responsibilities were assumed by the U.S. Air Force's Air Weather Service (DET 13, 20th WS), now the 35th Operational Support Squadron, Weather Flight.

2. **Assigned Support Functions**.

Products and services provided are oceanographic data and Navy-unique atmospheric products. Although a majority of this detachment's operational activity is in support of ASW, capabilities exist to provide mission unique meteorological support that is not available from the Air Force Weather Flight.

a. **Commands Supported**:

(1) Commander, Task Group SEVEN TWO PT FOUR.

(2) Patrol Wing One Detachment Misawa.

(3) Japanese Maritime Self Defense Force (JMSDF) ASWOC Hachinohe, under the command of COMFAIRWING TWO.

(4) U.S. Naval Air Facility Misawa.

(5) U.S. Air Force 35th OSS, Weather Flight

(6) VQ-1 Detachment Misawa

(7) VQ-5 Detachment Misawa

3. **Specific Products Available**.

Listed in NAVPACMETOCINST 3140.1H and C3140.22 are some of the specific products available to our users. In-house capabilities exist to produce many of these items. Products can be ordered via message (NAVPACMETOC DET MISAWA JA //00//), or by phone (STU-III AV 226-3298/3289). NPMOD non-secure FAX number is 226-3282.

a. **Specialized Support Products**:

(1) ASW Packets

(2) IREPS Packets

(3) Strike Packets

(4) SAR Packets

(5) Weekly Environmental updates

(6) Oceanographic Staff Briefs

(7) ASW Crew Briefs/Debriefs

(8) OPARS

(9) Mine Warfare Support

(10) Navy unique environmental products for local Naval units, including typhoon information.

4. **Resources**.

a. **Personnel**: Basic Allowance authorizes 1 officer and

07 enlisted Aerographer's Mates (AGs).

b. **Equipment**:

(1) SMQ-11

(2) Tactical Environmental Support System 3.3 (TESS III) which provides:

(a) Atmospheric Analysis

(b) Meteorological programs

(c) Electromagnetic Propagation programs

(d) Oceanographic programs

(e) Acoustic programs

(f) Satellite Applications programs

(2) Mobile Oceanographic Support System (MOSS). Contains many of the applications listed under TESS.

(3) Naval Oceanographic Data Distribution System (NODDS):

(a) FLENUMMETOCCEN's NOGAPS meteorological products

(b) Typhoon Warnings

(c) Sea Surface Temperatures

(d) Fronts and Eddies

(4) Optimum Path Aircraft Routing System (OPARS).

(5) Local User's Terminal (LUT): Used to receive real-time data from Drifting Meteorological Buoys on surface pressure, air and sea temperature, subsurface temperatures, and current drift.

(6) Defense Data Network (DDN).

(7) CONTEL Meteorological Workstation (PACMEDS)

SECTION II
AREA OF RESPONSIBILITY

1. **Misawa AOR**.

NPMOD Misawa's AOR consists of three major oceanic basins, 1) the Sea of Japan, 2) the Sea of Okhotsk, and 3) the Northwestern Pacific. The region is located in the mid-latitudes along the Pacific Ocean's western boundary and is extremely diverse. Environmental effects on weapons, sensors, and communications must be considered by mission planners. Some references which are readily available (see reference section) will provide a fundamental background to the region. The coasts surrounding the ocean basins consist of volcanic mountain ranges, part of the Pacific's "Rim of Fire". The trenches created by the adjacent subduction zone are among the deepest in the world. Earthquakes are frequent in the AOR.

2. **Seasonal Variations**.

Seasonal changes in the AOR are severe, going beyond the monsoonal wind shifts. Sea ice covers most of the Sea of Okhotsk and associated straits during the winter. Sonic layer depths during the summer are typically at the surface but hundreds of feet deep during the winter. Snow showers in the region during winter can rapidly degrade mission capabilities due to low ceilings and poor visibility. The AOR is complex and demands the attention of mission planners.

SECTION III
PHYSICAL OCEANOGRAPHY

1. Western North Pacific.

The Oceanography of the western North Pacific is dominated by two opposing current systems, the Kuroshio and the Oyashio. The strong ocean current system is unlike any other in the world, although the Kuroshio is often compared to the Gulf Stream. The confluence of the warm Kuroshio Current and cold Oyashio Current along the east coast of Japan creates a dynamic "perturbed zone" of fluctuating ocean fronts and eddies. Horizontal temperature gradients of up to 15 degrees Fahrenheit in less than 20 NM are often observed. Set and drift are varied in this mosaic of ocean currents and meandering offshoots. It is a deep basin, bordered by deep ocean trenches nearly 23,000 feet deep along the western and southwestern edges. Steep insular slopes along the Japan and Kuril Island chains mark the westernmost boundary. The Northwest Pacific Rise is centered at 33N-168E, with depths ranging from 16,000 feet to 8,250 feet. The major features of this water basin are:

a. **Kuroshio Current:** The Kuroshio originates with the Pacific North Equatorial Current. The source waters of the Kuroshio turn northward off the east coast of Luzon in the northern Philippines and flow northward across the eastern end of the Luzon Strait and the east coast of Taiwan. The Kuroshio passes the northern third of Taiwan and turns northeastward, flowing as a strong, warm, narrow current between the west side of the Ryukyu Island Arc and the 100 fathom curve of the East China Sea. As the Kuroshio approaches the northern end of the Ryukyu chain it splits into two branches. One branch continues northward along the west coast of Kyushu and Honshu as the Tsushima Current. The other branch of the Kuroshio turns eastward south of Kyushu and flows along the southeast coasts of Honshu and Shikoku before leaving the Japanese coast near 35N in the vicinity of the Boso Peninsula and Cape Inubozaki. The average speed of the Kuroshio Current is 2-3 knots with top speeds up to 5 knots found south and east of Honshu. The current begins to meander east of 142E, forming undulations with amplitudes of 50-250 NM and wavelengths of 150-250 NM resulting in the formation of numerous warm and cold eddies. The Kuroshio south of Shikoku, enters the Sea of Japan as the Tsushima. The water of the Kuroshio Current comprises of the following three basic types:

(1) Upper Surface Water: Subtropical mode water and subartic intermediate water. Characterized by warm temperatures (> 68 F), saline water (34.5 to 35.1 ppt), and extends 300 to 400 feet in depth. It is this layer in which the seasonal thermocline forms due to surface heat fluxes. Underlying the Surface Water is the Subtropical Mode Water.

(2) Subtropical Mode Water: This forms an intermediate layer to a depth of 1000-1200 feet with a remarkably uniform temperature between 64-66 F and is similar to the 66 F water in the North Atlantic south of the Gulf Stream. This water type may be responsible for the formation of shallow sound channels in the summer and extremely deep layer depths in the winter. Underlying the subtropical mode water is the Main Thermocline.

(3) Main Thermocline: Varying in temperature from 64-46 F, the Main Thermocline is created by the underlying Subarctic Water.

b. **Oyashio Current**: The Oyashio current is the western boundary of the subpolar gyre in the northwestern North Pacific. It originates in the Bering Sea and flows southward down the east coasts of the Kamchatka Peninsula, the Kuril Islands and Hokkaido. At least two branches of the Oyashio develop along the northeastern coast of Hokkaido. These branches, sometimes called the Inner and Outer branches, form intrusions of cold subarctic water into the warmer waters brought northward by the Kuroshio, intermingling into the complex water mass of the Perturbed Zone. These intrusions occasionally pinch off, forming eddies. The warm eddies are gradually modified and absorbed by the surrounding cold water, soon to be replaced by another warm intrusion. The cold eddies appear to slowly sink.

Perturbed Zone: This area extends from near the Japanese coast eastward to beyond 160E and north-south from 37N to 50N. The perturbed zone is a complex area of eddies and meanders formed by the intermingling of the warm and cold waters of the Kuroshio, Oyashio, and Tsugaru currents. It has been described as four parallel rows of stationary cyclonic/anticyclonic vortices (Barkley,1968).

2. **Sea of Japan**.

This is a marginal sea with four narrow, shallow straits providing access to the adjacent Pacific Ocean and Sea of Okhotsk. It is a complex sea which provides a myriad of oceanographic and meteorological conditions. The oceanographic conditions are dominated by the shallow straits, opposing warm and cold currents, fresh water sources, and bathymetry. The shallow straits restrict free water exchange with the North Pacific allowing the formation and maintenance of a cold and less saline Deep Water, called the Japan Proper. The opposing warm and cold currents establish a mid-Sea of Japan oceanographic Polar Front between the distinctly warmer southern portion and the cold waters in the northern sector. River run-offs and sea ice melt provide sources of colder fresh water which affects coastal oceanography and later becomes modified into Deep Water. The bathymetry is complex, with continental shelves that are steep and narrow except for the extreme northern portion, where the entire sea north of the Tsugaru Strait lies above a wide continental slope. Two major troughs exist, the Tartar and the Yamato, both of which have steep slopes. The Japan Abyssal Plain occupies the central northern sea comprising approximately 20 percent of the Sea's floor. The significant oceanographic features of this Basin are:

a. **Vertical structure**:

(1) Surface Layer: The Surface Layer is strongly

influenced by seasonal changes. It extends down to about 100 feet displaying a very high salinity in the Tsushima Strait, yet low salinity along the Asian coast. Surface isotherms typically parallel a northeast to southwest pattern. When examining the ASW characteristics of the Sea of Japan, there are distinct differences between the northwestern and southeastern sectors. These two areas are separated by a mid-Sea of Japan Polar Oceanographic Front. One of the major differences of the northwestern waters is the stratification and destratification during the summer and winter. Because of the destratification, half-channel conditions exist in the northwestern sector during the winter.

(2) Middle layer: This layer is comprised of water transported by the Tsushima Current. In this middle layer is found the main thermocline with temperatures decreasing from 62 F at 80 feet to 32 F at 660 feet. The thickness of this layer varies, both by season and location. It is thinner to the north and along the East Asian coastlines.

(3) Deep water: or Japan Proper, fills the entire basin below 660 feet and is remarkably uniform in temperature and salinity (32-33f, 34.0-34.1 ppt). It is this layer which contributes to the shallowness of the sound velocity channel.

b. **Sea of Japan Currents: (fig 23)**

(1) Tsushima Current: As stated earlier, the Kuroshio Current splits forming a branch which enters the Sea of Japan via the Tsushima Strait. It is this branch which is named the Tsushima current. The speed of the Tsushima Current flowing through the strait shows seasonal variability with a maximum of 1.5 knots in August and a minimum of 0.3 in winter. On entering the Sea of Japan, part of the Tsushima Current branches off as the Korea Warm Current which flows as far north as the area off Yongill Bay and Yllung Island (38N-131E), before veering southeastward to rejoin the main flow off the west coast of Japan. The main portion of the Tsushima Current is about 100 NM wide, having a speed of 1.0 to 1.5 knots. The current

continues up the west coast of Japan exiting the SOJ via the Tsugaru Strait at speeds up to 6 knots and the La Perouse/Soya Strait at speeds up to 4 knots. Numerous warm and cold eddies form due to the complexity of the Sea's currents. s

(2) Liman Current: In addition to the warm currents arising from the Tushima Current, there are three cold currents that are collectively called the Liman Current. The Liman Current exists along the Belkan coastline, arising from river run-off, Tartar Strait flow, and modified recirculating Tsushima water. As the Liman current flows southward, it branches into the Mid-Sea of Japan Cold and the North Korea Cold currents. The currents form a counterclockwise flowing gyre in the northwestern Sea of Japan. The speeds of the currents are weaker than the Tsushima current, typically at 0.3 to 0.5 knots. Cold eddies and vortices form off the currents and are discernible via satellite imagery.

(3) The Mid-Sea of Japan Ocean Front: This front is the most significant of the ocean fronts found in the Sea of Japan. It is formed by the confluence of the cold Liman waters and the warmer Tsushima waters. The surface temperatures across the front can range from 59 F in the south to 38 F just 60 NM to the north. In the summer, the below layer gradient tends to be stronger in the north.

3. **The Sea of Okhotsk**.

It is approximately 1 1/3 times as large as the Sea of Japan. The maximum depth is approximately the same as the Sea of Japan, however there are marked differencesin the bathymetry andoceanography. The Sea of Okhotsk bathymetry's most outstanding features are the gently sloping continental/insular slopes and the Kuril Basin. The Kuril Basin lies along the southern periphery of the Sea and reaches depths of 3000 meters. Steep escarpments border the Kuril Basin with slopes of 15-20 degrees. The shallow Tartar and La Perouse Straits connect the Sea of Okhotsk and Sea of Japan with minimal exchange of water. The Kuril Islands separate the Sea of

Okhotsk from the Pacific Ocean; with several deep straits providing free exchange of water between the two. The currents flow counter-clockwise at .6-1.0 knots. The Sea of Okhotsk is never ice free, having a maximum ice coverage in March. After ice melt has progressed, a significant layer of cold water (-1.6 to -2.0 C) exists at about 150 M depth between the surface layer and warmer Pacific-borne waters.

SECTION IV
<u>TACTICAL OCEANOGRAPHY</u>

1. **General Tactical Considerations**.

Much of what has been labelled "Tactical Oceanography" is simply stated as knowing the environment. Water mass characteristics affect sound propagation paths; therefore, knowledge of oceanographic features is imperative. As outlined earlier in this handbook, many oceanographic features exist in this complex area. Ocean fronts, eddies, swift currents, and irregular bathymetry are prevalent. This section will briefly review ocean features and their tactical implications.

a. **The sound velocity profile**: Mainly dependent on the water temperature profile, the SVP gives a snapshot of the working environment. Sound ray paths and resulting propagation loss will differ, depending on the source depth. The most exploitable feature of a SVP is the sonic layer depth, or the depth of the maximum sound speed. The SLD is easily approximated by the mixed layer depth. A sound source at the SLD will undergo "dipolar spreading" in which the sound intensity decreases by $1/r^4$, as r (range) increases. This is much greater than the loss incurred if a target is in a sound channel such as the surface layer. The greater the "below layer gradient" of either sound speed or temperature, the greater the spreading loss will be for a sound source operating at, or just below, the SLD. The existence of a shadow zone and the dipolar spreading phenomena argues against placing a receiver in the thermocline or at the SLD.

b. **Sound channels**: Sound channelling caused by surface ducts, shallow sound channels, or deep sound channels is also exploitable. Deep sound channels are often difficult to access yet may prove operationally effective if a receiver can be placed within the mid-three quarters of the DSC. Shallow sound channels may not be geographically widespread, hence not tactically useful. They may exist around fronts and provide extended ranges if a sound source is placed in the channel. Sound channels have a cut-off frequency which helps determine their tactical significance. If the frequency of interest is above the cut-off then extended ranges may be expected. Frequencies twice the cut-off frequency are more reliably ducted. Frequencies below cut-off will not be ducted.

c. **<u>Ocean fronts and eddies</u>**:

(1) <u>Fronts</u>: Fronts will vary the SLD, BLG, and the horizontal gradient. Bearing errors occurring due to horizontal temperature gradients may result in erroneous AOP's. Examining the first 1000 feet, one can see the very steep isospeed slopes. The downward refraction of the sound rays can often increase multipath detection, such as bottom bounce, to the south of the front. Other factors such as ambient noise and sea state may also be affected. Prosecuting a target through a front requires flexibility in tactics. Changes in the SLD, DSCA, and ambient noise influence the operator's choice of receiver depths.

(2) <u>Eddies</u>: These are best conceptualized as circular fronts, also effecting the SLD, BLG, and DSCA. Warm core eddies are found to the north of associated currents and cold core eddies are found to the south. In the perturbed zone, warm eddies formed by the Kuroshio may exist next to cold core eddies formed by the Oyashio.

(a) Warm Core Eddies: The SLD changes are dramatic and operationally significant. A sound source in the center of the warm eddy will have good direct path ranges because the increased likelihood of ducting. However, detection across the eddy's edge may only be possible through CZ and bottom bounce propagation paths.

(b) Cold Core Eddies: Because the DSC shallows, becoming more accessible, a cold core eddy is an acoustic "lens", betraying targets trying to seek refuge within the eddy. Because cold core eddies are generally found south of currents and contain denser water than the surrounding waters, they tend to sink or their surface becomes heated through insolation, thus making them difficult to detect by infra-red imagery. Warm core eddies, being less dense, can be detected for longer periods.

(c) Perturbed Zone: In this region, an operator must be aware of the environment likely to be encountered. Surface temperatures may mislead tacticians as to the significance of an ocean front. This region has cold and warm intrusions which often separate into eddies. Northern warm eddies/intrusions are undercut by the southward flowing subarctic waters of the Oyashio. This increases the BLG, increases the SLD, and DSCA and intensifies the below surface fronts. An example of this is where the warm Tsugaru water creates a surface front along 14330E of moderate strength. At the 50 M level, the cold Oyashio has pushed against the warmer waters creating a very strong front. At 100 M the gradient has weakened and the center of the of the feature has moved southwest. During one P-3C mission, 3 AXBT's indicated no ocean front according to the SST analysis. At about 200 feet, a 10 F difference between two of the three AXBT's existed. These AXBT's were only 15 NM apart! LESSON LEARNED: Don't assume the surface feature is representative of the entire water column and don't rely on one bathythermograph in this complex region.

d. **Topographic Effects**: The theory of upslope and downslope enhancement depends upon the slope of the ocean floor. Sound rays transmitted up a moderately steep slope will display increasing arrival angles with each bottom interaction, thus increasing chances of multipath detection. Downslope enhancement relies on sound rays propagating down the slope, eventually transforming from a bottom bounce to a deep sound channel propagation. Due to the high bottom loss regions, very steep slopes, and high ambient noise found in this area, P-3 assets have shown very little tactical advantage to be gained using upslope/downslope enhancement theories. However, due to the steep slopes, signal noise may be impeded by the rapidly rising bathymetry. It is more likely that upslope/downslope enhancement and topographic stripping is an advantage to the submarine than the airborne ASW assets. In summary, this AOR presents a very complex environment which should be studied in detail when planning Naval operations.

2. AOR Rules of Thumb.

a. **Forecasted Frontal Effects**: Forecasted oceanographic and acoustic changes across an ocean front are an important consideration for planning to ASW forces. When bathythermograph data is not available for the specific area of concern, the following thumb rules should be used.

(1) Kuroshio Front: When operating in the vicinity of the Kuroshio expect:

(a) Changes in temperature of 18 F in 50 to 60 NM.

(b) Surface sound speed changes as great as 100 feet per second in 35 to 40 NM.

(c) Sonic Layer Depths rapidly increase to 400-600 feet when entering the Kuroshio current during the winter.

(d) Below layer gradient changes when crossing the front.

(e) Deepening of the deep sound channel axis: 1000 to 1500 feet from north to south when crossing the front, particularly in winter.

(f) Increased ambient noise and reverberation caused by increased biologics in the vicinity of the front.

(g) Bearing errors caused by sound rays crossing the front at oblique angles.

(h) Water color changes from grayish green to a deep cobalt blue when crossing the front from . north to south.

(2) <u>Oyashio Front</u>: When operating in the vicinity of the Oyashio expect:

(a) Changes in temperature 16 to 18 F in 25 to 30 NM.

(b) Shallow sound channels produced by interfingering of alternating layers of warm and cold water.

(c) Changes in surface sound speed of 130 to 140 feet per second in 25 to 30 NM.

(d) Deepening of the DSCA 1500 to 2500 feet from north to south when crossing the front with 2500 feet of change common in winter.

(e) Increased ambient noise and reverberation caused by increased biologics in the vicinity of the front.

(f) Bearing errors caused by sound rays crossing the front at oblique angles.

(g) Water color changes from brownish colored to colbalt blue when crossing the front from north to south.

(3) <u>Liman/Tsushima Front</u>: When operating in the vicinity of the Liman/Tsushima Front expect:

(a) Changes in temperature 8 to 12 F in 60 NM.

(b) Bearing errors caused by sound rays crossing the front at oblique angles.

(c) Water color may change from bluish green to blue with transparency variations between 30 and 80 feet.

b. **<u>Actual Frontal Effects</u>:**

(1) When BTs can be dropped at a perpendicular line to the front, actual temperature gradients, sound velocity

gradients, and changes in the sound channel axis can be determined with vertical cross sectional analysis of the data. Plots of distance versus depth with a quantity such as sound velocity or temperature contour produce a visual means of depicting the strength of the front. From these data, an actual frontal effect can be calculated, verified, and used for future reference.

SECTION V
THE WEATHER

1. **Seasonal Climatology**.

The weather is a crucial element in Naval operations. During winter, cloudy conditions persist as storms track through the Misawa AOR. The detachment remains capable of providing Navy unique area forecasts but the responsibility for aviation pre-flight forecasting remains with the 35th Operational Support Squadron, Weather Flight. Due to the unique situation of not having the responsibility for meteorological pre-flight briefing support. The Forecasters Handbook developed by Naval Pacific Meteorology and Oceanography Facility Yokosuka, and Detachments Kadena and Atsugi provide an excellent reference for meteorological phenomena in this region. For background on local Misawa AB weather, write to: Commander 35th Operational Support Squadron, Weather Flight, APO AP, 96319-5000 and request a copy of the Terminal Area Forecast Reference Handbook.